NONCONTINGENT REINFORCEMENT AS A TREATMENT FOR SEVERE BEHAVIOR DISORDERS

By

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TABLE OF CONTENTS

page

ACKNOWLEDGMENTS ii

ABSTRACT iv

INTRODUCTION 1

- NCR as a Control Procedure 2
- Therapeutic Effects of NCR 7
- NCR as a Function-based Intervention 9
- NCR: Parametric Manipulation and Procedural Variations 12
- Limitations of NCR 14
- Mechanisms Underlying Effectiveness 16

EXPERIMENT 1: FUNCTIONAL ANALYSIS 18

- Method 18
- Results and Discussion 22

EXPERIMENT 2: A COMPARISON OF PROCEDURES FOR THINNING NONCONTINGENT REINFORCEMENT SCHEDULES 26

- Method 27
- Results and Discussion 30

EXPERIMENT 3: SATIATION AND EXTINCTION DURING NONCONTINGENT REINFORCEMENT 34

- Method 36
- Results and Discussion 38

GENERAL DISCUSSION 48

REFERENCES 51

BIOGRAPHICAL SKETCH 56

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Noncontingent reinforcement (NCR) has become an increasingly popular treatment for severe behavior disorders. NCR involves the delivery of reinforcers independent of responding, typically on a time- or trial-based schedule. The present research examined several aspects of NCR when used as a treatment for severe behavior disorders.

During Experiment 1, functional analyses of self-injurious behavior (SIB) or aggression were conducted for five individuals diagnosed with mental retardation. The assessment was used as a screening procedure to identify those individuals who engaged in problem behavior maintained by social-positive reinforcement.

Two methods of NCR schedule thinning were compared in Experiment 2. The fixed procedure consisted of increasing the NCR schedule in fixed increments. Under the adjusting schedule, changes were based on the mean interresponse time (IRT) of problem behaviors: As problem behaviors decreased, the mean IRT increased, resulting in a leaner NCR schedule. Results showed that both procedures were effective in

suppressing problem behaviors. Furthermore, the adjusting IRT procedure led to thinning of the NCR schedule that was slightly more efficient than the fixed procedure.

Experiment 3 examined if the mechanism of effectiveness of NCR changed from satiation to extinction as the schedule was thinned. Determination of the operative mechanism was based on examination of within-session response patterns observed during the NCR session and the extinction session that immediately followed it. Satiation during NCR would lead to a temporary increase in responding during the Post-NCR (extinction) session. Alternatively, if extinction was responsible for behavioral suppression during NCR, responding should remain low during the Post-NCR (extinction) session because the contingency for the problem behavior would remain the same across the NCR and Post-NCR (extinction) sessions. Results showed that, for two individuals, the mechanism changed from satiation to extinction as the NCR schedule was thinned. The results for the other participants showed that satiation for one individual and extinction for the other were responsible for behavioral suppression throughout NCR schedule thinning.

INTRODUCTION

Research on the treatment of severe behavior disorders (e.g., self-injurious behavior or SIB, aggression, property destruction, etc.) has a long-standing history in the field of behavior analysis. Not surprisingly, much of this research has focused on interventions based on the manipulation of reinforcement contingencies that may maintain problem behavior. Generally, these interventions consist of the weakening of response-reinforcer relationships and/or establishment of alternative responses that replace the function of the problem behavior. One example of this type of intervention is differential reinforcement of other behavior (DRO), in which reinforcement is delivered for the absence of responding (Catania, 1998). DRO, along with differential reinforcement of alternative behavior (DRA) and extinction, are the most common interventions for severe behavior disorders that involve contingency manipulation (Kahng & Iwata, 1999).

In contrast to the above treatments for problem behaviors, noncontingent reinforcement (NCR) involves the delivery of reinforcers according to a schedule that is independent of responding. In recent years, there has been a renewed interest in the use of NCR as a therapeutic intervention (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). The present research examines several aspects of the delivery of reinforcers in the absence of a known contingency (i.e., NCR) when used as a treatment for severe behavior disorders.

It should be noted that the term "noncontingent reinforcement" is inaccurate because it contradicts the definition of reinforcement. That is, reinforcement by definition, is contingent upon a response. Additionally, NCR does not lead to a reinforcement effect of increased responding; in fact, NCR often leads to a reduction in responding. Several alternatives to the term NCR have been proposed; these include fixed-time (FT) reinforcement, response-independent reinforcement, free reinforcement, and random reinforcement. However, these alternative terms, all of which contain the term "reinforcement," are as problematic as NCR. Additionally, there are several advantages to the term NCR over the suggested alternatives. First, NCR unambiguously conveys the absence of a contingency between a response and the delivery of a reinforcer. Second, NCR is more flexible than FT reinforcement because NCR can also be delivered on variable-time (VT) or trial-based schedules. Third, NCR is synonymous with response-independent reinforcement. Finally, NCR is more specific than free and random reinforcement. In fact, random reinforcement suggests the absence of a schedule, which is not true of NCR.

Although the term NCR may not be an ideal term, it is sufficiently descriptive, as good or better than the alternative terms, and has precedent in use in both basic (Lane, 1960) and applied research (Bushell, Wrobel, & Michaelis, 1968; Hart, Reynolds, Baer, Brawley, & Harris, 1968). Moreover, there is precedent for the use of the label "reinforcement" in reference to procedures that do not produce a reinforcement effect. For example, "DRO" is a widely accepted term. Yet, reinforcement is not delivered contingent upon any particular response. Rather, reinforcement is contingent on the absence of a particular response and elapsed time. Furthermore, as in the case of NCR, DRO does not lead to an increase in responding.

NCR as a Control Procedure

There has been a long history of the use of NCR in the field of behavior analysis. One such application of NCR, particularly in basic operant research, has been as a contingency-control procedure (e.g., Edwards, Peek, & Wolfe, 1970; Lattal, 1972). One of the first studies that used NCR as a contingency-control procedure in operant research was conducted by Rescorla and Skucy (1969). They examined the effects of NCR on bar-pressing exhibited by male rats in a series of experiments. During Experiment 1, bar pressing was maintained on a variable interval (VI) schedule. During Experiment 2, the rats were divided into four groups. The first group (Group VI) continued to receive reinforcement (food pellets) on the same VI schedule as in Experiment 1. The second group (Group E) no longer received any reinforcement (i.e., extinction). Group three (Group R) continued to receive food pellets. However, the schedule of reinforcer delivery was yoked to the VI schedule of the first group (Group VI); therefore, this group received food pellets independent of bar pressing (i.e., NCR). The procedures for the last group (Group D) was identical those of Group R, except that reinforcers were never delivered within 5 seconds of a bar press. This condition was designed to rule out the possibility of adventitious reinforcement. Results showed that Group VI continued to respond at rates similar to those exhibited during Experiment 1, whereas responding decreased for the other three groups (Groups E, R, and D). Furthermore, the overall decrease in responding observed in these three groups was similar, although the decrease in responding for Group R (i.e., NCR) was somewhat slower than that of Group E (i.e., extinction).

Hammond (1980) examined the parametric effects of a contingency on free-operant responding by varying the probabilities of reinforcement for responding and not responding. A contingency was defined as the difference between the probability of reinforcement for responding and the probability of reinforcement for not responding. Thus, a difference greater than zero was a positive contingency, a difference equaling zero was the contingency-control condition (i.e., NCR), and a difference less than zero was a negative contingency.

In Experiment 1, Hammond examined the effects of a shift from a positive contingency to a zero contingency on response rates using 10 experimentally-naive male rats. The probabilities of reinforcement for responding and not responding under the positive contingency condition were 0.05 and 0.0, respectively. Under the contingency-control condition, the probabilities of reinforcement given a response and no response were both 0.05. Thus, the difference between the two equaled zero. Results showed a substantial decrease in responding following the introduction of the zero contingency. Experiment 2 examined response rates following a shift from a high positive contingency to a lower positive contingency, to a zero contingency, or to a high negative contingency. Results of this experiment showed a decrease in responding that was much greater following a shift from a positive contingency to a negative contingency than from a positive contingency to a zero contingency.

The use of NCR as a contingency-control procedure has not been limited to basic research. Several studies have demonstrated the contingency-control feature of NCR in applied research. For example, Bushell et al. (1968) examined the use of a token economy to increase the studying behavior of preschool age children. Delivery of tokens was contingent upon actively engaging in individual activities (e.g., Spanish) and participating in study teams (i.e., study behavior), which resulted in high levels of studying. Bushell et al. then delivered tokens noncontingently, which resulted in a subsequent decrease in studying.

Hart et al. (1968) evaluated the effects of contingent and noncontingent social reinforcement on cooperative play (e.g., handing objects to other children, sharing toys, etc.) exhibited by a five-year old girl. During the contingent reinforcement phase, a teacher smiled at, laughed and conversed with, and admired the participant when she engaged in cooperative play. The same reinforcers were delivered at random intervals throughout the school day in the noncontingent reinforcement condition. Results showed an increased rate of cooperative play when reinforcers were delivered contingently and lower rates when reinforcers were delivered noncontingently.

Finally, Goetz, Holmberg, and LeBlanc (1975) compared DRO and NCR as control procedures while evaluating a treatment to increase compliance with adult requests. Their participant was a 3-year-old child attending preschool. The authors initially increased compliance by presenting verbal praise contingent upon each occurrence of compliance. They compared these results with those obtained under NCR (reinforcement delivered following compliance and noncompliance) and DRO (reinforcement delivered contingent on every instance of noncompliance). Responding was more variable and suppression was slower under NCR than under DRO. Goetz et al. concluded that DRO was the preferred control procedure. However, one limitation of this study was the delivery of NCR in discrete trials in which reinforcers were delivered following compliance on some trials and following noncompliance on others. Thus, results of the NCR/DRO comparison were somewhat confounded because NCR may have functioned as intermittent reinforcement for compliance.

These studies highlight the potential for the use of NCR as a contingency-control procedure. Despite numerous demonstrations of the utility of NCR in both basic and applied research, extinction continues to be the most common control procedure. This may be a function of the amount of effort required to implement extinction versus NCR. It is likely that less effort is required to discontinue the delivery of reinforcers than to deliver reinforcers independent of responding. The latter requires that the experimenter develop an NCR schedule and deliver reinforcers based on that schedule, whereas the former typically requires little or no response by the experimenters. However, NCR may ultimately be better than extinction as a contingency-control procedure because of the reduced likelihood of side effects (e.g., extinction bursts) often associated with extinction.

One area in which NCR is commonly used as a contingency-control procedure is in the functional analysis of severe behavior disorders. This analysis typically involves the systematic manipulation of reinforcement contingencies suspected of maintaining the problem behavior. Test conditions contain contingencies for the emission of the target behavior (i.e., problem behavior), whereas the control condition does not. Therefore, increased rates of responding in a test condition relative to the control condition would be indicative of sensitivity to a particular contingency.

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) presented a methodology for conducting a functional analysis of SIB. The participants were exposed to four conditions (three test conditions and one control). The social disapproval condition, which involved the delivery of brief attention by the experimenter to the participant contingent upon SIB, was a test for SIB maintained by social-positive reinforcement. During the demand condition, instructional tasks were presented by the experimenter to the participant. SIB resulted in a brief escape from tasks. This condition tested for SIB maintained by social-negative reinforcement. The final test condition was the alone condition. The individual was alone in a room, and no social reinforcement was delivered. Persistence of SIB in the absence of social reinforcement suggested that SIB was maintained by automatic reinforcement (Vaughn & Michael, 1982). The control condition was referred to as the unstructured play condition. Leisure items were freely available, demands were not presented, and attention was delivered on an FT schedule (i.e., NCR). Thus, both positive and negative social reinforcement were available independent of responding, resulting in a lower probability of the establishment of a functional relationship between the response and the reinforcer. NCR, rather than extinction, was used as the control because of the potential for a temporary increase in responding sometimes associated with extinction (i.e., extinction burst). Therefore, the unstructured play condition was a direct extension of research on the contingency-control features of NCR, and its use during assessment suggested that access to reinforcers on a response-independent basis may serve as an alternative means of decreasing behavior. That is, the use of NCR as a control in functional analysis suggests that it may have beneficial therapeutic effects.

Therapeutic Effects of NCR

In one of the earliest demonstrations of the use of the principles of behavior analysis on an applied problem, Ayllon and Michael (1959) used NCR for the treatment of problem behaviors. In one experiment, the authors focused on the treatment of hoarding behavior (e.g., collecting paper, trash, and magazines) exhibited by four patients living in a psychiatric hospital. Treatment consisted of ignoring the behavior and giving unlimited access to materials by continually replenishing the supply (i.e., satiation), which resulted in a decrease of the hoarding behavior. Ayllon and Michael concluded that reinforcer satiation can be an effective intervention for problem behaviors. One limitation of the study was that the effects of NCR were confounded because the function of the hoarding behavior was unknown; thus, ignoring the behavior (i.e., extinction) may have also led to the decrease.

Satiation procedures have also been used as a common treatment for vomiting and rumination exhibited by individuals diagnosed with developmental disabilities (e.g., Johnston, Greene, Rawal, Vazin, & Winston, 1991; Rast, Johnston, & Drum, 1984; Rast, Johnston, Drum, & Conrin, 1981; Wilder, Draper, Williams, & Higbee, 1997). One of the first studies examining NCR as a treatment for this topography of SIB was conducted by Jackson, Johnson, Ackron, and Crowley (1975). They examined the effects of food satiation (i.e., NCR) on rumination exhibited by two individuals diagnosed with developmental disabilities. Baseline consisted of the delivery of the participants' regular meal portions. During the treatment condition, the individuals were given unlimited access to food until they emitted food refusal behavior (e.g., pushing the food away) twice during a 1-min interval. Results showed that the satiation procedure was highly effective in decreasing rumination for one individual and moderately effective for the other.

A common treatment for other types of problem behaviors has been to provide continuous access to sources of reinforcement that may not function to maintain the problem behavior. For example, Bailey and Meyerson (1970) evaluated the effects of an alternative source of reinforcement (i.e., vibration) for the treatment of SIB. Their participant was a child diagnosed with developmental disabilities who engaged in biting. In condition one, the participant received 6 seconds of access to the vibratory stimulus contingent upon pressing a lever. In the second condition, the individual received 10 minutes of continuous access to the vibrator independent of responding (i.e., NCR). Both conditions resulted in a decrease in SIB, although continuous access resulted in a greater reduction.

Favell, McGimsey, and Schell (1982) also examined the efficacy of alternative sources of reinforcement as treatment for SIB in a series of experiments. Six individuals diagnosed with developmental disabilities participated in their study. All participants engaged in SIB consisting of hand mouthing, eye poking, and/or pica. During Experiment 1, the participants were provided continuous access to toys (NCR), which resulted in a decrease in SIB relative to baseline. Subsequently, the experimenters made access to the toys contingent upon the appropriate manipulation of those toys (DRA) rather than the less-desirable topography of toy mouthing. This resulted in a slightly greater decrease in SIB than did free access to reinforcers. The authors replicated these findings with a different topography (eye poking) in Experiment 2. During Experiment 3, the participants were given free access to toys, popcorn, or both for the treatment of pica (NCR), and results indicated that continuous access to either stimulus was effective in reducing pica. Finally, the experimenters made access to popcorn contingent upon appropriate toy manipulation (DRA). This was only effective in reducing pica for one individual. The authors concluded that continuous access to alternative sources of reinforcement may be an effective treatment for SIB.

NCR as a Function-based Intervention

Operant assessment techniques based on functional analysis methodology have become common over the last 15 years in research on the treatment of SIB and other behavior disorders (i.e., aggression and property destruction) exhibited by individuals diagnosed with developmental disabilities (Pelios, Morren, Tesch, & Axelrod, in press). This methodology has aided in the development of function-based interventions that have several advantages over interventions that are selected arbitrarily (Iwata, Vollmer, & Zarcone, 1990). First, the identification and alteration of antecedent conditions (i.e., establishing operations and discriminative stimuli) is made possible with the use of a pretreatment functional analysis. Second, once the reinforcers maintaining the behaviors are identified, the source of reinforcement can be minimized or eliminated (i.e., extinction). Third, the same reinforcer that maintains the problem behavior may be used to establish an alternative response. Finally, the information provided by a functional analysis may permit one to eliminate treatment components (e.g., reinforcers) that may be irrelevant to the overall reduction of the target behavior.

The renewed interest in NCR as a function-based treatment for severe problem behaviors may be attributed to a study conducted by Vollmer et al. (1993), who compared the effectiveness of DRO and NCR in reducing SIB exhibited by three individuals diagnosed with developmental disabilities. A functional analysis indicated that all individuals engaged in SIB maintained by attention, which was delivered contingent upon each occurrence of SIB during baseline. Following baseline, the authors compared the efficacy of DRO and NCR using a multielement experimental design. During the DRO condition, reinforcement was delivered contingent upon the absence of SIB during brief intervals of time (10 s). In the NCR condition, reinforcers were delivered independent of the individual's responding on an FT 10 s schedule. The DRO and NCR schedules were eventually thinned to 5 minutes as the individuals continued to emit low rates of SIB. The results of the comparison indicated that DRO and NCR were equally effective in suppressing SIB. The authors concluded that NCR may be a viable alternative to DRO because of its ease of implementation.

Social-positive Reinforcement

The Vollmer et al. (1993) study was one of the first to use NCR as a treatment for behavior maintained by social-positive reinforcement. Since its publication, there have been numerous replications and extensions of the applicability of NCR (e.g., Derby, Fisher, & Piazza, 1996; Hagopian, Fisher, & Legacy, 1994; Hanley, Piazza, & Fisher, 1997; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997; Lalli, Mace, Livezey, & Kates, 1998; Marcus & Vollmer, 1996). For example, Fischer, Iwata, and Mazaleski (1997) implemented NCR as a treatment for SIB exhibited by two individuals diagnosed with mental retardation. A functional analysis indicated that both participants' engaged in SIB maintained by social-positive reinforcement (attention and access to a tangible item). Several food items (arbitrary reinforcers), which were demonstrated to be irrelevant to behavioral function, were identified through a preference assessment. The authors subsequently evaluated the effectiveness of two NCR interventions. During the first NCR condition (NCR without extinction), arbitrary reinforcers were delivered on an FT 10 s schedule while each occurrence of SIB resulted in access to the maintaining reinforcer. Following this condition, arbitrary reinforcers were again delivered independent of responding. However, the NCR schedule was progressively thinned and occurrences of SIB no longer produced access to the maintaining reinforcer (NCR with extinction). Results showed that the delivery of arbitrary reinforcers during NCR was effective in decreasing SIB, even when the target behavior was concurrently reinforced. These findings indicated that the noncontingent delivery of preferred items, which were irrelevant to behavioral function, could be effective in reducing problem behavior.

Social-negative Reinforcement

Relative to studies investigating behaviors maintained by social-positive reinforcement, fewer studies have examined the use of NCR for behavior maintained by social negative reinforcement (e.g., Kahng, Iwata, DeLeon, & Worsdell, 1997; Piazza, Contrucci, Hanley, & Fisher, 1997). Vollmer, Marcus, and Ringdahl (1995) conducted one of the first demonstrations of NCR as a treatment for escape-maintained problem behaviors. They provided noncontingent breaks from task engagement for two individuals for whom escape was a reinforcer (as determined from a functional analysis). During baseline, a therapist delivered instructions to the participants. Contingent upon SIB, the individual briefly escaped the demand. Treatment consisted of the delivery of demands, similar to baseline. However, both participants received a break immediately following each instruction, independent of SIB (i.e., NCR). Finally, the effects of NCR were compared to DRO for one participant. During DRO, escape was provided contingent upon the absence of SIB for a specified period of time. Results indicated that NCR was effective in reducing escape-maintained SIB for both participants. Additionally, NCR was as effective as DRO for one individual.

Automatic Reinforcement

Shore, Iwata, DeLeon, Kahng, and Smith (1997) examined the use of NCR for the treatment of SIB maintained by automatic reinforcement by three individuals. A functional analysis indicated that SIB occurred most often in the absence of programmed social consequences (i.e., the alone condition), suggesting that the response was maintained by automatic reinforcement. During Experiment 1, the participants were given continuous access to preferred toys (based on a stimulus preference assessment), which resulted in the near elimination of SIB. Additionally, the authors noted an increase in the manipulation of toys to nearly 100% of the intervals. Experiment 2 consisted of the use of the same reinforcers (i.e., toys) in a DRO procedure. The toys were delivered contingent upon the absence of SIB for a specified DRO interval. Results of this experiment showed little decrease in SIB relative to baseline under the DRO condition. Shore et al. concluded that for their participants, continuous access to toys effectively competed with SIB, whereas the use of the same reinforcers in a DRO procedure was ineffective.

These studies demonstrated the efficacy of NCR as a treatment for problem behaviors maintained by social reinforcement (positive and negative) as well as by automatic reinforcement. Additionally, several studies have examined the use of NCR with other problem behaviors (e.g., Day, Horner, & O'Neill, 1994; Hanley et al., 1997) and different populations (e.g., Bloxham, Long, Alderman, & Hollin, 1993; Knight & McKenzie, 1974).

NCR: Parametric Manipulation and Procedural Variation

Schedules

Research suggests that NCR is more effective in suppressing responding under dense rather than lean schedules. Dense schedules have typically consisted of continuous or near continuous delivery of reinforcers (e.g., FT 10 s), whereas lean schedules have been set at an arbitrarily determined FT 5-min. Hagopian et al. (1994) examined if a lean NCR schedule would result in decreases in problem behaviors. Their participants were quadruplets diagnosed with developmental disabilities whose problem behaviors (i.e., SIB, aggression, and property destruction) were maintained by social-positive reinforcement (i.e., attention). During baseline, attention was delivered contingent upon problem behaviors. Following baseline, Hagopian et al. compared the dense (FT 10 s) and lean (FT 5-min) NCR schedules in a multielement design. Their results indicated that, for all participants, the dense NCR schedule resulted in greater reductions in the problem behaviors.

Reinforcer Magnitude

Carr, Bailey, Ecott, Lucker, and Weil (1998) examined the effects of magnitude of reinforcement, while holding rate constant, on the suppressive effects of NCR. Their participants were five individuals diagnosed with developmental disabilities. Rather than using problem behaviors as the dependent variable, Carr et al. decreased arbitrary responses (dropping poker chips into a plastic cylinder) with NCR. During baseline, the arbitrary response was reinforced on an FR 1 schedule, which was eventually thinned to variable ratio (VR) 3 or VR 5. Following baseline, the authors evaluated three NCR conditions based on magnitude (high, medium, and low) of reinforcement. In the high magnitude condition, a predetermined quantity of food was delivered independent of responding. Under the medium magnitude condition, half of the amount of food (relative to the high magnitude condition) was delivered. Finally, during the low magnitude condition, a third of the amount of food (relative to the high magnitude condition) was delivered independent of responding. Results showed that the arbitrary response was suppressed during the high magnitude condition for all five participants. Under the medium magnitude condition, responding decreased with only two participants. Finally, there was little decrease in responding for any participants under the low magnitude condition.

Schedule Thinning

To date, most studies examining NCR have thinned the schedule irrespective of the individual's rates of responding (e.g., Hagopian et al., 1994; Vollmer et al., 1993). That is, the initial NCR schedule is typically based on an arbitrarily determined FT value (e.g., FT 10 s) and eventually thinned by increasing the FT value according to fixed increments. The second experiment of this dissertation compared two methods of NCR schedule thinning -- one based on procedures typically used (i.e., fixed increments of time) and the other based on the individual's rate of responding (i.e., interresponse time or IRT) -- to determine which procedure would result in quicker thinning of the NCR schedule.

Limitations of NCR

Adventitious Reinforcement

Although no explicit contingencies are established with NCR, the possibility exists that some proportion of responses may be followed by reinforcers. This potential correlation between response and reinforcer may lead to response maintenance through adventitious reinforcement (Skinner, 1948). Vollmer, Ringdahl, Roane, and Marcus (1997) documented adventitious reinforcement as a potential limitation of NCR. Their initial NCR schedule resulted in near continuous access to reinforcers, which led to a decrease in the problem behavior exhibited by an individual diagnosed with developmental disabilities. As the NCR schedule was thinned, Vollmer et al. noted a gradual increase in responding as the schedule reached one reinforcer per minute. A within-session analysis revealed that problem behavior often occurred just before the delivery of scheduled reinforcers, and Vollmer et al. concluded that adventitious reinforcement during NCR may have been responsible for the increase in responding because of the correlation between response and reinforcers.

Alternative Response

Another potential limitation to NCR may be that it does not explicitly result in an increase of alternative, more appropriate behaviors. In fact, it is possible that NCR may interfere with the acquisition of alternative responses. That is, NCR may reduce (through satiation) the effectiveness of a reinforcer (i.e., alter the establishing operations) for the problem behavior as well as for the alternative response. Marcus and Vollmer (1996) examined if satiation effects may contraindicate the use of NCR when also attempting to increase appropriate behaviors with the same reinforcer maintaining the problem behavior (e.g., differential reinforcement of alternative or DRA). The participants were 3 individuals diagnosed with developmental disabilities who engaged in SIB or aggression. A functional analysis suggested that their problem behaviors were maintained by social-positive reinforcement. Two of the three participants were exposed to NCR plus DRA, in which the same reinforcers were delivered noncontingently on an FT schedule (i.e., NCR) and contingent on each occurrence of an alternative response (i.e., DRA).

During baseline, the preferred stimuli were delivered contingent upon each occurrence of SIB or aggression. Following baseline, the participants were taught to emit an alternative response to receive reinforcement. Following this training phase, the authors evaluated the effects of NCR in combination with DRA. The initial NCR schedule was based on the approximate mean of the baseline rate of reinforcement (3 reinforcers per minute). SIB and aggression were extinguished, whereas the alternative response resulted in reinforcement on an FR 1 schedule. Thus, if differential reinforcement failed to produce increases in the alternative behavior, this would suggest that NCR may have interfered with the emission of the alternative response by leading to satiation to the reinforcer. The results of their study showed that the combination of NCR and DRA led to continued suppression of problem behaviors. Furthermore, the alternative response increased as the NCR schedule was systematically thinned. The authors concluded that NCR may not interfere with the emission of alternative responses. Additionally, these data suggest that satiation was not a factor in the effectiveness of NCR.

Mechanisms Underlying Effectiveness

The use of NCR as a treatment for severe behavior disorders typically consists of dense schedules of reinforcer delivery. Therefore, the noncontingent delivery of reinforcers may lead to the momentary alteration of establishing operations (Michael, 1982). That is, the continual delivery of reinforcers may lead to satiation to the reinforcer, which may account for the suppression in responding (Vollmer et al., 1993). Lalli et al. (1997) conducted a series of experiments related to this issue. The final experiment evaluated the effectiveness of NCR without extinction as a treatment for SIB. The participant was a 7-year-old boy diagnosed with severe mental retardation and severe behavior disorders. During the NCR condition, the participant was given 30 second access to a preferred object on an FT schedule. Additionally, SIB continued to be concurrently reinforced on an FR 1 schedule. Results showed an initial increase in the rate of SIB (relative to baseline), which eventually decreased to near zero levels. Thus, given that extinction was not necessary for response suppression, the authors concluded that satiation was the mechanism responsible for behavior reduction.

An alternative operative mechanism may be extinction. That is, the disruption of the response-reinforcer contingency may lead to what amounts to extinction (Rescorla & Skucy, 1969). This hypothesis may be supported by the findings of Marcus and Vollmer (1996). Given that the participants' alternative responses increased when both NCR and DRA were in effect, it would suggest that the individuals were not satiated (via NCR) to the reinforcers, but rather, the reduction was a result of extinction.

One explanation for the discrepant findings of Lalli et al. (1997) and Marcus and Vollmer (1996) may be that both satiation and extinction are responsible for the effectiveness of NCR. That is, initially dense NCR schedules may result in satiation to the reinforcer. However, satiation becomes unlikely as the NCR schedule is thinned because fewer reinforcers are delivered. Therefore, the operative mechanism may change from satiation to extinction as the NCR schedule is thinned. The third experiment of this dissertation evaluated whether the mechanism of NCR changes from satiation to extinction and attempted to identify the point at which this change may occur.

EXPERIMENT 1: FUNCTIONAL ANALYSIS

Over the past two decades, functional analysis has become the most common method of assessing problem behaviors (Didden, Duker, & Korzilius, 1997). Functional analysis involves observation of behavior under a series of controlled environmental conditions to identify maintaining contingencies for problem behavior (Iwata et al., 1990). Because the use of NCR in Experiments 2 and 3 required the delivery of reinforcers that maintained problem behavior, functional analyses were conducted for all participants in Experiment 1. The functional analysis was used as a screening procedure to identify those individuals who engaged in problem behavior maintained by social-positive reinforcement.

Method

Participants and Settings

The participants (Table 1) were five individuals diagnosed with developmental disabilities. All participants lived in a state residential facility and had limited communication skills. None emitted vocal speech, although they did emit simple gestures (e.g., pointing) to indicate some of their needs. All participants were diagnosed with severe or profound mental retardation. Julia was a 43-year-old female diagnosed with a seizure disorder. She received dilantin and phenobarbitol throughout this study (at a constant dose) to control seizures. Her SIB consisted of skin picking. Lisa was a 27-year-old woman who engaged in SIB consisting of head/body hitting and hand biting.

Nancy was a 50-year-old woman who engaged in SIB consisting of head/body hitting. Susan was a 31-year-old female diagnosed with seizure disorder, cerebral palsy, and Angelman Syndrome. She received a constant dose of depakote throughout the study to control seizures. She engaged in SIB consisting of arm hitting and aggression consisting of hitting, scratching, pinching, and kicking others. Matt was a 25-year-old male who engaged in SIB consisting of hand or arm biting.

Table 1
Subject characteristics and NCR experiment in which they participated

Name	Age	Diagnosis	Topography	Experiment
Julia	43	severe MR seizure disorder	skin picking	2, 3
Lisa	27	profound MR	head/body hit hand bite	2, 3
Nancy	50	profound MR	head/body hit	2
Susan	31	profound MR cerebral palsy seizure disorder Angelman Syndrome	arm hitting hitting others scratching others pinching others kicking others	3
Matt	25	profound MR	hand/arm bite	3

All individuals were referred to a day clinic, located on the grounds of the residential facility, for the assessment and treatment of their SIB. Sessions were conducted in therapy rooms located in the clinic. Each room contained several chairs, a table, and other materials necessary to run therapy sessions (e.g., work material, toys, etc.).

Data Collection and Reliability

An observer used a hand-held computer (Assistant, Model AST102) to record frequencies of SIB during continuous 10-s intervals throughout the sessions. Data were summarized as the number of self-injurious or aggressive responses per minute. Additionally, data were collected on experimenters' implementation of assessment and treatment procedures (e.g., delivery of instructions, prompting, and consequences).

A second observer simultaneously but independently collected data. Agreement percentages were then calculated based on an interval-by-interval comparison of observers' records (Table 2). The smaller number of responses in each interval was divided by the larger number of responses in each interval. These proportions were summed across all intervals and divided by the total number of intervals in the session to obtain the percentage agreement between the observers.

Table 2
Percentage of sessions with interobserver agreement and interobserver agreement scores for all participants during the functional analysis

Participant	Percent of Sessions with Interobserver Agreement	Interobserver Agreement Scores
Julia	20.0%	99.7% (range, 98.9% to 100.0%)
Lisa	46.7%	95.4% (range, 69.0% to 100.0%)
Nancy	37.5%	96.9% (range, 94.9% to 97.8%)
Susan	36.0%	99.0% (range, 95.6% to 100.0%)
Matt	39.3%	94.2% (range, 74.6% to 100.0%)

Functional Analysis

Each individual was exposed to four assessment conditions (Alone, Attention, Demand, and Play). Two individuals were exposed to a fifth condition (Tangible). The procedures were similar to those described by Iwata et al. (1982/1994). All sessions were 15 minutes in length.

Alone. The individual was in a therapy room. An experimenter was not present nor were leisure materials available. The purpose of this condition was to determine if problem behavior persisted in the absence of social reinforcement, which would suggest that problem behavior was maintained by automatic reinforcement.

Attention. An experimenter was present, and the room contained various leisure materials. At the beginning of the session, the experimenter prompted the individual toward the materials. No social interaction was provided to the participant unless the individual engaged in problem behaviors, at which time the experimenter approached the participant and provided brief social attention (e.g., "Don't do that, you'll hurt yourself") and light physical contact. The purpose of this condition was to determine if problem behaviors were maintained by social-positive reinforcement in the form of attention.

Demand. The participant was seated at a table with the experimenter. Instructional trials were presented on an FT 30 s schedule using a three-step graduated prompting procedure (verbal instruction, demonstration, physical guidance). Prompts were delivered at 5 s intervals if compliance did not occur. Brief praise was delivered contingent upon compliance with the request. If the individual emitted problem behaviors during the instructional trial, the experimenter terminated all interaction and turned away from the individual until the beginning of the next trial. The purpose of this condition was to determine if SIB was maintained by social-negative reinforcement in the form of escape from tasks.

Tangible. This condition was conducted only if previous information suggested that a tangible item may function to maintain problem behavior. An experimenter was present throughout the session. A tangible item (i.e., food) was given to the individual contingent upon problem behaviors. No other form of attention was delivered. This condition tested for access to food as a reinforcer for problem behaviors.

Play. Leisure items were available throughout the session. An experimenter delivered noncontingent attention on an FT 30 s schedule. All problem behaviors were ignored (i.e., extinction). This condition served as the control condition.

Results and Discussion

Julia's SIB (Figure 1, top panel) occurred most often during the attention condition of the functional analysis and rarely occurred during the other conditions, suggesting that her SIB was maintained by attention. Lisa (Figure 1, middle panel) exhibited the most SIB during the tangible condition, suggesting that her SIB was maintained by access to food (a small amount of pickles). Nancy (Figure 1, bottom panel) engaged in SIB in all four conditions of the functional analysis. However, responding was substantially higher during the attention condition, indicating that her SIB was maintained primarily by attention. Finally, both Susan and Matt (Figure 2) exhibited initially low rates of destructive behaviors during their functional analyses. Susan's rates of SIB and aggression (top panel) during the attention condition increased (relative to the other conditions) by the fourth attention session and continued to remain high during the remainder of her functional analysis. Therefore, Susan's functional analysis suggested that her SIB and aggression were maintained by attention. Similarly, Matt's SIB (bottom panel) increased by the fourth tangible session of his functional analysis and maintained for the remainder of the assessment. Therefore, the results of his functional analysis suggested that his SIB was maintained by access to food (M&Ms).

The results of all five individuals' functional analyses indicated that their problem behaviors were maintained by social-positive reinforcement in the form of attention or access to tangible items (i.e., food). The results of the functional analysis in Experiment 1 served as the basis for the NCR evaluations in Experiment 2 and 3.

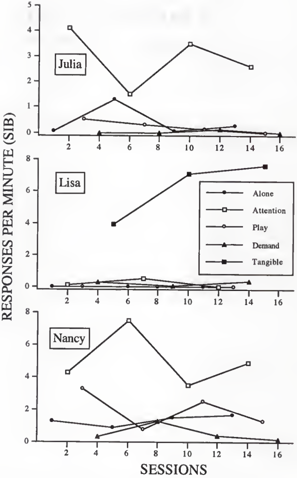

Figure 1. Responses per minute of SIB during functional analysis for Julia (top panel), Lisa (middle panel), and Nancy (bottom panel).

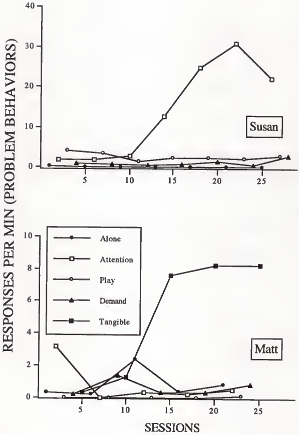

Figure 2. Responses per minute of problem behaviors during functional analysis for Susan (top panel) and Matt (bottom panel).

EXPERIMENT 2: A COMPARISON OF PROCEDURES FOR THINNING NONCONTINGENT REINFORCEMENT SCHEDULES

One of the primary advantages of NCR over other reinforcement-based interventions, such as DRO, is ease of use (Vollmer et al., 1993). In DRO, a caregiver must continuously observe the individual to ensure that the criterion for reinforcement (i.e., no responding) has been met. However, this is unnecessary under NCR because the schedule is not affected by the individual's behavior. Although NCR may be easier to implement than DRO, NCR may still be cumbersome to implement given that it typically requires dense initial schedules (Hagopian et al., 1994). Therefore, thinning NCR schedules may be an important determinant of procedural integrity.

Typically, the initial NCR schedule is often set at a dense value (e.g., FT 10 s). The schedule is then thinned according to specified criteria (e.g., Vollmer et al., 1993) using fixed increments of time. However, this is a somewhat arbitrary process that does not take into account the individual's rate of responding. This arbitrary process may result in an unnecessarily slow thinning process, or to schedules that are hastily increased, which may lead to an increase in problem behavior.

Lalli et al. (1997) examined several procedural variations of NCR, one of which was the determination of the initial NCR schedule. The participants were two children admitted to an inpatient unit specializing in the treatment of severe problem behaviors. Both were diagnosed with developmental disabilities and engaged in aggression and SIB. Their initial NCR schedule was based on the mean latency to the first problem behavior during the functional analysis. This resulted in initial schedules of FT 90 s for one individual and FT 120 s for the other. There was a substantial decrease in the problem behavior for both participants following the introduction of NCR, even though the initial NCR schedule was much leaner than those previously used (e.g., Hagopian et al., 1994; Vollmer et al., 1993). These data suggest that leaner NCR schedules, based on rates of responding, may be effective in reducing problem behaviors.

Although Lalli et al. used relatively lean NCR schedules to decrease problem behaviors, latency to the first response may not be an accurate reflection of the individual's rates of responding throughout an entire session. Furthermore, Lalli et al. subsequently thinned their NCR schedule based on fixed increments of time. An alternative method for both determining the initial NCR schedule and subsequently thinning reinforcement may be to derive the schedules from the mean interresponse time (IRT) for the target behavior. That is, the NCR schedule could be determined prior to each session by calculating the mean IRT of previous sessions. Thus, the mean IRT increases as responding decreases, resulting in a thinning of the NCR schedule. The purpose of Experiment 2 was to examine the utility of thinning the NCR schedule based on the mean IRT of problem behavior. This alternative method of NCR schedule thinning was compared to a more common thinning procedure that was based on fixed increments (Vollmer et al., 1993).

Method

Participants and Settings

The participants were Julia, Lisa, and Nancy from Experiment 1. Settings and materials were identical to those of Experiment 1.

Data Collection and Reliability

Data collection and calculation of interobserver agreement were identical to those of Experiment 1. Interobserver agreement was assessed for Julia, Lisa, and Nancy during 35.3%, 51.8%, and 33.3% of the baseline and treatment sessions, respectively. Mean interobserver agreement scores for Julia, Lisa, and Nancy were 98.7% (range, 95.6% to 100.0%), 95.9% (range, 72.1% to 100.0%), and 95.9% (range, 89.2% to 100.0%), respectively.

Experimental Sequence and Design

Following Experiment 1, two simultaneous baselines were implemented for all three participants. Each baseline was conducted in a different therapy room with a different experimenter to enhance discrimination between the two NCR schedule thinning conditions. Following baseline, the NCR intervention was introduced according to a multiple baseline across subjects design. The two NCR schedule thinning procedures were evaluated using a multielement design.

Treatment Conditions

Baseline. An experimenter was present throughout the session, and leisure materials were available. The baseline contingencies were identical to those of the functional analysis condition in which responding was highest. Julia and Nancy received approximately 5 to 10 s of attention (e.g., "Don't do that, you will hurt yourself") contingent upon SIB, and Lisa received a small amount of pickles contingent upon SIB. Reinforcement was delivered on an FR 1 schedule for all participants during baseline.

Noncontingent reinforcement. During the two NCR conditions, the therapist delivered the same reinforcers as in baseline. However, reinforcers were delivered on an FT schedule, independent of the individual's responding. Additionally, there were no programmed consequences for SIB.

The Fixed NCR schedule thinning procedure was based on Vollmer et al. (1993). The initial NCR schedule was always set at FT 10 s. If SIB was at or below 0.5 responses per minute for a given session, the NCR schedule was increased in the subsequent session according to fixed increments (Table 3). The schedule of reinforcer delivery was thinned from an initial rate of 6 per minute (FT 10 s) to a rate of 0.2 reinforcers per minute (FT 5-min).

During the Adjusting IRT NCR schedule thinning condition, the initial schedule was based on the mean IRT of the last 3 baseline sessions. Before each subsequent NCR session, the schedule was determined by calculating the mean IRT of the previous 3 sessions. In order to prevent large, sudden decreases in responding from dramatically lengthening the NCR schedule, the schedule of reinforcer delivery for a given session was limited to a maximum of a 100% increase from the previous session's NCR schedule.

Table 3
Schedule Thinning Increments (Fixed Condition)

Reinforcers	NCR schedule	Reinforcers	NCR schedule
6/min	FT 10 s	1/min	FT 1-min
5/min	FT 12 s	.5/min	FT 2-min
4/min	FT 15 s	.33/min	FT 3-min
3/min	FT 20 s	.25/min	FT 4-min
2/min	FT 30 s	.2/min	FT 5-min

The terminal NCR schedule was FT 5-min for both NCR conditions. Therefore, schedule thinning was stopped once the NCR schedule reached FT 5-min. The criterion for completion of the NCR condition was SIB at or below 0.5 responses per minute for 5 consecutive sessions at the FT 5-min schedule. All sessions (baseline and treatment) were 15 minutes in duration.

Results and Discussion

Figure 3 shows data from the comparison of the two NCR schedule thinning procedures. Julia's responding during both baselines was variable (Figure 3, top panel). During baseline for the Fixed and Adjusting IRT conditions, Julia averaged 3.1 and 3.5 SIBs per minute, respectively. Following the introduction of NCR, there was an immediate decrease in SIB under both the Fixed and Adjusting IRT conditions (M = 0.1 per minute and 0.2 per minute, respectively). The initial NCR schedule under the Adjusting IRT condition was FT 15 s based on the mean IRT of the last three sessions of baseline. As previously stated, the initial NCR schedule under the Fixed condition was always FT 10 s. The terminal NCR schedule (FT 5-min) was reached in 6 sessions under the Adjusting IRT condition, compared to 10 sessions under the Fixed condition.

The reduction in Lisa's SIB (Figure 3, middle panel) following the introduction of NCR was more gradual than that observed for Julia. During baseline, Lisa averaged 9.4 SIBs per minute in the Fixed condition and 8.0 SIBs per minute in the Adjusting IRT condition. NCR resulted in a decrease in the Fixed condition to 1.8 SIBs per minute and in the Adjusting IRT condition to 2.0 SIBs per minute. The terminal NCR schedule of FT 5-min was reached quicker under the Adjusting IRT condition (11 sessions) compared to the Fixed condition (15 sessions).

Finally, NCR led to an immediate reduction in Nancy's SIB (Figure 3, bottom panel). During baseline, Nancy averaged 4.1 and 5.8 SIBs per minute in the Fixed Adjusting IRT conditions, respectively. SIB decreased to 0.6 per minute during the Fixed NCR condition and to 1.2 per minute during the Adjusting IRT condition. The NCR schedule was thinned to the terminal schedule in 15 sessions under the Adjusting IRT condition compared to 25 sessions under the Fixed condition.

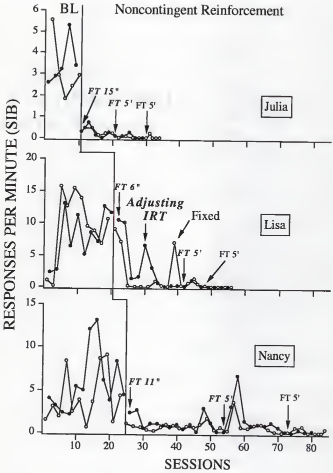

Figure 3. Responses per minute of SIB during baseline and treatment conditions for all participants. The initial NCR schedule under the Fixed Condition was always FT 10 s. Italicized text represents the NCR schedule under the Adjusting IRT condition.

The results of this study indicated that both NCR schedule thinning procedures were effective in reducing problem behavior. Additionally, the NCR schedule was thinned to a terminal value somewhat quicker using a procedure based on the individual's rate of responding (i.e., the Adjusting IRT procedure). That is, for all participants, it took fewer sessions to reach FT 5-min using the Adjusting IRT procedure when compared to the Fixed method of schedule thinning. Therefore, the Adjusting IRT procedure may be a viable alternative to the Fixed procedure, especially in light of the fact that the Adjusting IRT procedure was somewhat more efficient. For two of the three participants (Julia and Nancy), NCR produced immediate reductions in SIB, resulting in increases of the NCR schedule under the Adjusting IRT condition that were much greater than the those resulting from the Fixed method of schedule thinning. Because of such low rates of SIB, it is possible that the terminal NCR schedule of FT 5-min using the Adjusting IRT schedule thinning procedure could have been reached in even fewer sessions. However, a limit of a 100% increase (i.e., double) from the previous NCR schedule was set to prevent dramatic increases in the NCR schedule from adversely affecting rates of responding. Hypothetically, it is conceivable that the terminal NCR schedule of FT 5-min could be reached by the fourth NCR session using the Adjusting IRT procedure if there was no limit to the increase in NCR schedule from previous session. That is, if no SIB was emitted during the first three NCR sessions, the mean IRT would equal 5 minutes resulting in an NCR schedule of FT 5-min. Future studies should focus on what effect this limit may have on NCR schedule thinning.

One limitation to this study may have been the minimum number of sessions required to reach the terminal schedule with both procedures. The Adjusting IRT procedure required a minimum of 4 sessions to reach the terminal schedule whereas the Fixed procedure required at least 10 sessions. It is conceivable that had the Fixed procedure been limited to 4 steps (i.e., schedule values) the outcome, in terms of the difference in the number of sessions it took to reach the terminal schedule, may have been different. However, we compared the Adjusting IRT procedure to the most commonly used NCR schedule thinning procedure (e.g., Vollmer et al., 1993; Hagopian et al., 1994).

Finally, one limitation to the use of NCR as a treatment for severe behavior disorders is the risk of adventitious reinforcement (Vollmer et al., 1997). In fact, there may be a greater risk of adventitious reinforcement associated with the Adjusting IRT procedure. There is a possibility that the correlation between the occurrence of SIB and the delivery of reinforcers may be higher given that the NCR schedule is based on the individual's rate of responding. This may be one possible explanation for the gradual decrease observed in Lisa's SIB following the introduction of the Adjusting IRT NCR condition. Her responding during the first 6 Adjusting IRT NCR sessions was higher than that obtained during the first 6 Fixed NCR sessions. However, the rapid thinning of the NCR schedule may have led to subsequent extinction of this adventitiously reinforced behavior.

One area of future research may be to examine the degree to which the NCR schedule may be thinned. Studies have not examined the possibility of thinning the NCR schedule beyond those typically used (i.e., FT 5-min). If it is possible to extend the NCR schedule beyond FT 5-min, the efficiency of the Adjusting IRT procedure (relative to the Fixed procedure) would also increase. Thus, it is possible that the difference in efficiency between the two schedule thinning procedures may also continue to increase so that the Adjusting IRT procedure would result in NCR schedules that are significantly leaner than those produced by the Fixed procedure.

EXPERIMENT 3: SATIATION AND EXTINCTION DURING NONCONTINGENT REINFORCEMENT

Because NCR typically involves dense schedules of reinforcer delivery, responding may be reduced through elimination of the behavior's establishing operation (Michael, 1982). A closer examination of the rate of reinforcer delivery for two of the participants in the Hagopian et al. (1994) study lends support to this hypothesis. That is, the mean rate of reinforcer delivery during the dense NCR condition was 6.0 per minute for two of the individuals, which was greater than the rate of reinforcer delivery during baseline. Thus, it is possible that the overabundance of reinforcers during NCR resulted in satiation to the reinforcer. Furthermore, results of two studies (Fischer et al., 1997; Lalli et al., 1997) showed that dense NCR schedules suppressed problem behaviors, even when each occurrence of problem behavior also produced reinforcement indicating that mechanisms other than extinction (presumably satiation) were responsible for behavioral suppression.

An alternative explanation for the effectiveness of NCR is that problem behavior decreases because it is extinguished (Vollmer et al., 1993). NCR contains an extinction component because NCR results in the removal of the response-reinforcer contingency (Rescorla & Skucy, 1969). One participant in the Vollmer et al. study emitted high rates of SIB during baseline relative to treatment. The mean rate of reinforcement during baseline was 22 per minute, whereas the densest rate of reinforcement during NCR was 6 per minute. Vollmer et al. noted that the rate of reinforcement during NCR may not have been sufficient to produce satiation, leading them to suggest that the effectiveness of NCR may have been due to extinction.

The findings of Marcus and Vollmer (1996) lend further support for extinction as the mechanism of effectiveness for NCR. They evaluated the effects of NCR when used in conjunction with DRA. Attention, which was the reinforcer maintaining problem behavior, was delivered noncontingently (NCR) and contingent upon emission of an alternative response (DRA). NCR + DRA led to a decrease in the problem behaviors. Additionally, the participants continued to engage in the alternative response, suggesting that they were not satiated to the reinforcer. Therefore, it is likely that some other mechanism (presumably extinction) was responsible for behavioral suppression during NCR.

An explanation for these seemingly discrepant results may be provided by further examination of the findings of the Hagopian et al. (1994) study. Although the rate of reinforcer delivery was much higher during the dense NCR condition (6 reinforcers per minute or FT 10 s) relative to baseline (suggesting satiation), response suppression was also observed in three of the four participants during the lean NCR condition, in which the rate of reinforcer delivery was 0.2 per minute (FT 5-min). This comparison of the dense and lean NCR schedules was relatively brief; had Hagopian et al. continued with the lean NCR condition, the problem behaviors may have decreased further from continued exposure to extinction. As Hagopian et al. thinned the dense NCR schedule, they noted that responding continued to be suppressed throughout the schedule thinning process. Thus, it is possible that dense and lean NCR schedules affect behavior differently but produce the same outcome. That is, removal of the establishing operation (i.e., satiation) may have been responsible for the reduction in problem behavior under dense NCR schedules; but, as the NCR schedule was thinned, the operative mechanism may have changed to extinction. Therefore, the purpose of Experiment 3 was to examine if the mechanism of effectiveness for NCR changes from satiation to extinction and to identify the point at which this change may occur.

Method

Participants and Settings

The participants were Julia, Lisa, Susan, and Matt from Experiment 1. Settings and materials were identical to those of Experiment 1.

Data Collection and Reliability

Data collection and interobserver agreement procedures were similar to those used in Experiment 1. Interobserver agreement was assessed during 20.0%, 42.9%, 42.9%, and 34.6% of the sessions during baseline and treatment for Julia, Lisa, Susan, and Matt, respectively. Mean interobserver agreement scores during baseline and treatment were 99.3% (range, 96.1% to 100.0%), 95.9% (range, 91.8% to 100.0%), 97.0% (range, 91.0% to 100.0 %), and 97.5% (range, 79.3% to 100.0%) for Julia, Lisa, Susan, and Matt, respectively.

Experimental Sequence and Design

Following baseline, the effects of NCR were evaluated using a multiple-baseline across subjects design.

Treatment Conditions

Baseline. All sessions were 10 minutes in length. Baseline contingencies were identical to the functional analysis conditions in which problem behavior was highest. Brief attention was delivered contingent upon SIB or aggression for Julia and Susan. Lisa and Matt were given a small amount of edibles (pickles and M&Ms, respectively) contingent upon SIB. All reinforcers were delivered on an FR 1 schedule.

Noncontingent reinforcement. Reinforcers identical to those used in baseline were delivered independent of problem behaviors on an FT schedule. There were no programmed social consequences for problem behaviors. The initial NCR schedules for Julia, Lisa, and Susan were based on the mean IRT of SIB or aggression during the last 3 baseline sessions. The NCR schedule was thinned in each subsequent NCR session based on the mean IRT of SIB or aggression during the previous 3 sessions. Therefore, as problem behaviors decreased the mean IRT increased, resulting in a leaner NCR schedule. Schedule thinning was discontinued once the NCR schedule reached FT 300 s.

NCR schedule thinning for Matt was more gradual because of a history of difficulty with thinning schedules of reinforcement. That is, previous thinning of reinforcement schedules (e.g., DRA) was unsuccessful in that problem behavior increased as reinforcement schedules were thinned. Therefore, Matt's initial NCR schedule was FT 5 s (12 reinforcers/min), which resulted in continuous access to reinforcers. Thinning of the NCR schedule was started after the third NCR session. If SIB was at of below 0.5 per minute, the delivery of 1 reinforcer per minute was deleted in the subsequent session. This continued until the NCR schedule reached FT 60 s or the delivery of 1 reinforcer per minute. At this point, the delivery of 1 reinforcer per session was deleted in each subsequent session until the terminal schedule of FT 300 s (i.e., 2 reinforcers delivery per session) was reached. All NCR sessions were 10 minutes in length.

Post-NCR (extinction). Immediately following each NCR session, a 20-minute extinction session was conducted. This condition was similar to baseline (i.e., same room, therapist present, etc.), except that no reinforcers were delivered.

Evaluation of the mechanism underlying the effectiveness of NCR was based on cumulative records of minute-by-minute patterns of responding during the NCR session and extinction session that immediately followed it. If the individual was satiated to the reinforcer during NCR, the Post-NCR (extinction) period would result in deprivation of the reinforcer, which may lead to a temporary increase in responding during the Post-NCR (extinction) session (Figure 4, left panel). Alternatively, if extinction was responsible for behavioral suppression during NCR, responding should continue to remain low during the Post-NCR (extinction) session because the contingency (i.e., extinction) for the problem behaviors would remain the same across the NCR and Post-NCR (extinction) sessions (Figure 4, right panel).

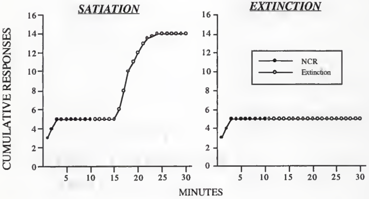

Figure 4. Hypothetical graphs representing cumulative records of within-session patterns of responding expected from satiation (top panel) and extinction (bottom panel) effects during NCR.

Results and Discussion

NCR data across sessions for all participants are presented in Figure 5. Lisa averaged 10.6 SIBs per minute during baseline (top panel). Initially, NCR (FT 5 s) did not result in a reduction of SIB. It was possible that the dense NCR schedule resulted in adventitious reinforcement of SIB. Therefore, an omission contingency, in which reinforcer delivery was deleted if SIB immediately preceded the scheduled delivery, was implemented in sessions 10 through 12. Lisa averaged 0.7 SIBs per minute during the last 9 NCR sessions (without the omission contingency).

NCR was effective in immediately decreasing SIB for the other three participants. Julia averaged 3.9 SIBs per minute (second panel). Following the introduction of NCR, SIB decreased to near zero levels (M = .03). Susan and Matt averaged 15.0 and 6.4 destructive responses per minute, respectively (third and fourth panels). NCR decreased responding to 4.4 and 0.4 responses per minute, respectively. For Matt, a brief extinction condition was conducted following the NCR phase (see Results for further details), which resulted in the continued suppression in responding (M = 0.04).

Given that conclusions about the effectiveness of NCR for Lisa could not be made when SIB continued to occur at high rates (i.e., NCR was not effective) or when the omission contingency was in place (i.e., no longer NCR), Lisa's within-session evaluation (Figure 6, top panel) was started at session 13 (FT 17 s). During session 13, responding decreased throughout the NCR session until no SIB was emitted during the last 4 minutes of the session. Termination of the delivery of reinforcers in the subsequent Post-NCR (extinction) session was followed by an increase of SIB, suggesting that satiation was responsible for behavioral suppression during the NCR session (session 13). Within-session patterns of responding indicative of satiation continued (e.g., see session 16, FT 128 s) until the NCR schedule was thinned to FT 235 s. At this schedule, the discontinuation of reinforcer delivery during the Post-NCR (extinction) session did not lead to an increase in responding, suggesting that the mechanism of effectiveness during NCR had changed to extinction. A similar response pattern was observed during the replication of the NCR FT 235 s schedule (e.g., session 21). Thus, it appears that the operative mechanism of NCR changed from satiation to extinction between sessions 16 (FT 128 s) and 17 (FT 235 s).

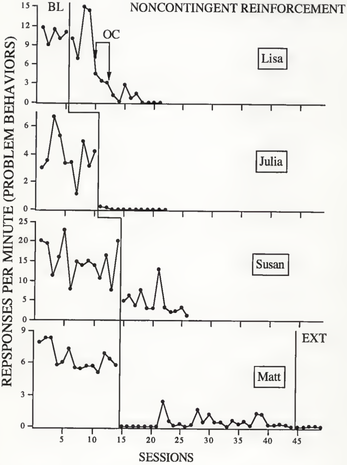

Figure 5. Responses per minute of problem behaviors (SIB for Lisa, Julia, Susan, and Matt; aggression for Susan) during baseline and the NCR condition.

Figure 6 (middle panel) shows representative samples of the within-session response patterns for Julia. As previously mentioned, NCR led to the near elimination of her SIB, which was also evident in her within-session patterns of responding (session 11, FT 15 s). The first and second Post-NCR (extinction) sessions were extended to 30 and 45 minutes during sessions 11 and 12, respectively, to ensure a sufficient period of deprivation to the reinforcer. However, responding did not increase during these Post-NCR (extinction) sessions, suggesting that extinction had been responsible for behavioral suppression during the preceding NCR sessions. Given that responding did not increase during the extended Post-NCR (extinction) sessions, the length of subsequent Post-NCR (extinction) sessions was decreased to 20 minutes for the remainder of Julia's sessions. Furthermore, the NCR schedule remained at FT 15 s to replicate the previous effects of extinction. SIB remained low throughout the NCR and Post-NCR (extinction) sessions (e.g., sessions 16 and 22).

Susan's within-session response patterns are shown in Figure 6 (bottom panel). The NCR schedule during the first NCR session (session 15) was FT 4 s. Responding in the subsequent Post-NCR (extinction) session showed a sharp increase in destructive behaviors within the first few minutes following the termination of NCR, suggesting that satiation was responsible for the effectiveness of NCR. This pattern of responding representative of satiation is also shown in session 17, although the increase in responding was more gradual than that observed during the first Post-NCR (extinction) session. Because of an increase in destructive behaviors during session 21 (not shown), the NCR schedule was changed to FT 9 s (session 23). Susan's responding during the subsequent Post-NCR (extinction) session showed that problem behavior did not increase, suggesting that extinction had been responsible for behavioral suppression during the preceding NCR session. NCR schedule thinning was discontinued at this point (FT 9 s), and the effects observed during FT 9 s were subsequently replicated (e.g., session 26).

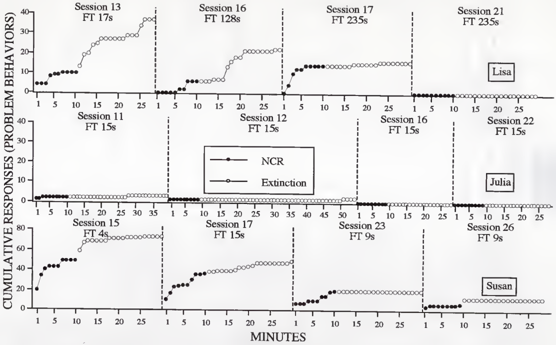

Figure 6. Representative samples of within-session response patterns (Lisa, Julia, and Susan) during NCR and Post-NCR (extinction) sessions.

Figure 7 shows representative samples of Matt's responding during the NCR and Post-NCR (extinction) sessions. The initial NCR schedule was FT 5 s (session 15). SIB increased during the subsequent Post-NCR (extinction) session, indicating that satiation may have been responsible for the efficacy of the preceding NCR session. As the NCR schedule was thinned, responding continued to increase during the Post-NCR (extinction) sessions (sessions 24, 27, 29, 31, 35, 39, 41, 42, and 43), suggesting that satiation was responsible for behavioral suppression during NCR. This pattern continued through FT 300 s (session 43). At this point, NCR was discontinued and five extinction sessions were conducted, which resulted in low rates of SIB throughout the sessions.

The results of this study suggest that the mechanism of effectiveness for NCR changed from an alteration of establishing operations (i.e., satiation) to extinction as the NCR schedule was thinned for two participants. That is, Lisa's and Susan's within-session response patterns during NCR and the Post-NCR (extinction) sessions suggested that satiation was initially responsible for behavioral suppression during NCR. However, as the NCR schedule was thinned, the mechanism of effectiveness during NCR changed to extinction.

It appears that extinction was responsible for the efficacy of NCR from the outset for Julia. That is, responding continued to remain low throughout the NCR and Post-NCR (extinction) sessions, even when the period of deprivation (i.e., Post-NCR [extinction]) was extended to 45 minutes. It is conceivable that the initial NCR schedule of FT 15 s was not sufficient to produce satiation, and had we used a denser schedule (e.g., FT 5 s), within-session patterns would have resembled satiation. However, the delivery of 5 to 10 seconds of attention during the NCR session (FT 15 s) resulted in the near continuous delivery of attention. Finally, results of Matt's within-session analysis suggested that satiation was responsible for the effectiveness of NCR throughout the schedule thinning. We included the final extinction phase to compare with the within-

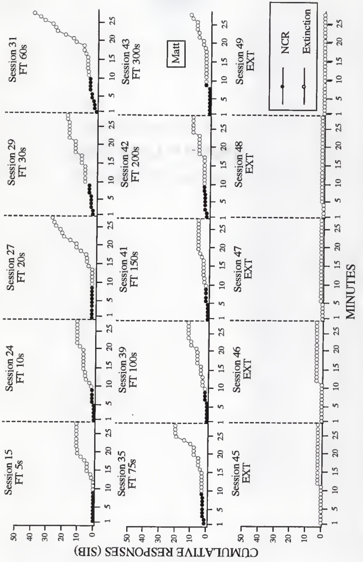

Figure 7. Representative samples of within-session response patterns (Matt) during NCR and Post-NCR (extinction) sessions.

session patterns during the NCR phase. Response patterns during the extinction phase (i.e., responding low throughout the session) were markedly different from those obtained during the NCR phase, further adding support to our conclusion that satiation was responsible for the efficacy of NCR throughout the thinning process. It is conceivable that, had we continued thinning Matt's NCR schedule, the mechanism of effectiveness may have changed to extinction. However, given the lengthy phase and the fact that numerous studies have stopped thinning at FT 5-min, we discontinued the schedule thinning. Alternatively, the outcome of Matt's within-session evaluation may have been affected by the different schedule thinning procedure. That is, Matt's NCR schedule thinning was more gradual than that used with other participants; had we thinned Matt's NCR schedule based on mean IRTs, the outcome may have been different.

Although the results for Lisa, Nancy, and Matt suggested that satiation was partly responsible for the effectiveness of NCR, one cannot rule out the possibility that extinction was a factor in the outcome of NCR. Extinction may have been responsible for behavioral suppression during the dense NCR session, and the increase in responding during the subsequent Post-NCR (extinction) session may have been due to a generalization decrement (Mazur, 1998). That is, there was a change in responding when the conditions of the test stimuli (i.e., the Post-NCR [extinction] session) became less and less similar to the conditions of the training stimuli (i.e., the NCR session). A change from a dense NCR schedule (e.g., FT 10 s) to the Post-NCR (extinction) session resulted in a greater change in stimulus conditions than a change from a lean NCR schedule (e.g., FT 5-min) to the Post-NCR (extinction) session. Therefore, there have been a higher probability that responding would change (i.e., increase) in the Post-NCR (extinction) session following this large change in stimulus conditions.

Several studies have demonstrated that NCR can be effective without extinction (e.g., Fischer et al., 1997; Lalli et al., 1997), suggesting that satiation may be responsible for behavioral suppression under dense NCR schedules. Given that Fischer et al. (1997)

only implemented NCR at very dense FT schedules, little can be said about the mechanisms underlying the effectiveness of NCR under leaner schedules. It is conceivable that had Fischer et al. thinned their NCR schedule, there would have been a deterioration of problem behaviors because the individual would no longer be satiated to the reinforcer, and problem behaviors would continued to be reinforced (i.e., no extinction).

Lalli et al. (1997) also demonstrated with one participant that NCR can be effective without extinction (i.e., problem behavior continues to be reinforced). However, it took several sessions before NCR produced a suppression in responding. This gradual reduction in SIB may have been a function of their lean, initial NCR schedule (FT 120 s). Unlike Fischer et al. (1997), Lalli et al. thinned the NCR schedule to FT 300 s without the use of extinction, which resulted in continued suppression of problem behavior. This outcome may be similar to that observed with our fourth participant, Matt. Matt's response pattern continued to resemble those of satiation as the NCR schedule was thinned to FT 300 s, suggesting that satiation was responsible for the effectiveness of NCR throughout the schedule thinning process. Similarly, Lalli et al. demonstrated that extinction was not a necessary component of NCR for their participant, even as the schedule was thinned, leading the authors to conclude that satiation was responsible for behavioral suppression.

This study adds to the existing body of research by demonstrating that NCR may affect behavior through different mechanisms (satiation and extinction), which may be related to the density of the NCR schedule. Not only is the identification of mechanisms underlying the effectiveness of NCR important from a conceptual viewpoint, but it may also have practical implications. These data suggest that, in some cases, it may be unnecessary to extinguish the problem behaviors at dense NCR schedules. This may prove to be beneficial to caregivers and individuals, given that it is sometimes difficult to implement extinction. For example, the nature of the problem behavior (e.g., severe SIB or aggression) may make ignoring the problem behavior impossible. Alternatively, there may be limitations to the caregiver's behaviors (e.g., physical limitations) that would make extinction impractical. These findings also suggest that, in some cases, it may be imperative that the problem behaviors are not reinforced when implementing lean NCR schedules to ensure that NCR remains effective in suppressing problem behaviors throughout the thinning process. That is, intermittent reinforcement of the problem behavior may lead to maintenance of the problem behavior during the NCR schedule thinning process.

GENERAL DISCUSSION

The development of NCR as a function-based intervention for severe behavior disorders has taken a unique path. Its use in behavior analysis originated as a contingency-control procedure in basic research, which eventually led to its use as a control procedure in applied research. The ability of NCR to suppress responding ultimately led researchers to use it as a treatment for severe behavior disorders.

Current NCR research has focused on procedural variations such as its use with a variety of behavioral functions (Shore et al., 1997; Vollmer et al., 1995), different topographies (Lalli, Livezey, & Kates, 1996; Piazza et al., 1998), and its use in conjunction with other interventions (Piazza, Moes, & Fisher, 1996). Additionally, recent research has focused on the identification of the mechanisms underlying the effectiveness of NCR by concurrently reinforcing problem behaviors (Fischer et al., 1997; Lalli et al., 1997), altering the magnitude of reinforcement (Carr et al., 1998), and examining its effects on alternative behaviors (Marcus & Vollmer, 1996).

Research on the use of NCR as a treatment for severe behavior disorders suggests the NCR schedule should be initially dense (Hagopian et al., 1994). This dense NCR schedule may lead to the momentary alteration of the behavior's establishing alteration (i.e., satiation). Alternatively, the effectiveness of NCR may be based on extinction, especially at leaner schedules. In these cases, NCR may lead to reductions of side effects (e.g., extinction burst) sometimes associated with extinction (Vollmer et al., 1998).

Research (Fischer et al., 1997; Lalli et al., 1997) also suggests that NCR may be effective at dense schedules without extinction (i.e., problem behavior continues to be reinforced). However, extinction should be incorporated into NCR as a method of eliminating ongoing reinforcement for problem behavior. If extinction cannot be implemented (e.g., severe aggression or SIB, behavior maintained by automatic reinforcement, etc.), it may be necessary to use very dense NCR schedules to eliminate the problem behavior.

Finally, Marcus and Vollmer (1996) suggested that NCR may not affect the occurrence of alternative responses maintained by the same reinforcers as the problem behavior. However, closer examination of their data showed that occurrence of the alternative behavior may have been correlated with gradual thinning of the NCR schedule. That is, at dense NCR schedules, the alternative response occurred at low rates; the alternative response did not increase until the NCR schedule was thinned. Therefore, an alternative explanation may be that dense NCR schedules may interfere with alternative responding; but, as the schedule is thinned, the likelihood that NCR will interfere with the alternative response decreases. This hypothesis was supported by the findings of Goh, Iwata, DeLeon, and Sorenson (1997). They used procedures similar to those described by Marcus and Vollmer (1996). However, their initial examination of NCR + DRA was conducted at a dense NCR schedule, which remained in effect throughout the entire phase. Their results showed that NCR suppressed both the problem behaviors and the alternative response. During the second NCR + DRA phase, Goh et al. thinned the NCR schedule and observed increases of the alternative behavior at NCR values. These findings suggest that one limitation to the use of NCR as a treatment for severe behavior disorders is that it may interfere with the emission of more appropriate behaviors that have the same function as the problem behavior. However, the findings of Goh et al. also suggest that the effects of NCR on the alternative response may be attenuated by thinning the NCR schedule.

Another limitation of NCR may the possibility of adventitious reinforcement of the problem behavior. Vollmer et al. (1997) observed an increase in SIB with one participant as the NCR schedule was thinned. A within-session examination showed that the participant's responding was closely followed by reinforcer delivery, leading Vollmer et al. to conclude that behavioral maintenance may have been due to adventitious reinforcement. The findings of Vollmer et al. are somewhat surprising because the probability that a reinforcer will follow a response decreases as the NCR schedule is thinned. One would expect that the risk of adventitious reinforcement would be greater earlier in the thinning process because the probability that a reinforcer will follow a response is greater at dense NCR schedules. This may be evident in Lisa's (Experiment 2 and 3) NCR data. Responding did not initially decrease during the NCR condition until the schedule was sufficiently lean to produce extinction (Experiment 2) or until reinforcer delivery no longer followed SIB (Experiment 3). An alternative explanation to the findings of Vollmer et al. may be that the increase in problem behaviors was a result of an extinction burst. This is particularly conceivable in light of the results of Experiment 3.

Finally, future studies may wish to examine the long-term effects of NCR. That is, most NCR studies have examined NCR during brief (10-15 minutes) sessions. However, it is unclear what the effects of implementing NCR throughout the entire day may have on problem behaviors. This may be particularly important when using a reinforcer that does not maintain the problem behavior (e.g., Fischer et al., 1997; Hanley et al., 1997). The continuous delivery of these arbitrary reinforcers may eventually lead to an increase in the problem behavior because the individual may become satiated to the reinforcer.

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BIOGRAPHICAL SKETCH

SungWoo Kahng was born in Seoul, South Korea, and emigrated to the United States in 1973. He attended Kalamazoo College in Kalamazoo, MI, and graduated in 1990 with a degree in psychology. After graduation, he found employment at the Kennedy Krieger Institute in Baltimore, MD. There he gained his first exposure to behavior analysis and individuals diagnosed with developmental disabilities. He served as a clinical specialist on the Neurobehavioral Unit conducting assessments and treatments of severe behavior disorders. His experience at the Kennedy Krieger Institute led him to seek graduate training in the field of behavior analysis. In the Fall of 1993, he enrolled in the experimental analysis of behavior program at the University of Florida to pursue a doctoral degree in psychology. He worked as a graduate research assistant at the Florida Center on Self-Injury from 1993 to 1998 under the supervision of Dr. Brian Iwata. Since Fall 1998, Mr. Kahng has been employed as a program specialist at the New England Center for Children located in Southborough, MA. Expecting graduation in summer 1999, he will return to the Kennedy Krieger Institute, where he will continue clinical work and research in the application of behavior analytic principles to the treatment of behavior disorders.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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